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Three Freshwater *Lembadion* Ciliates (Peniculida, Lembadionidae) Newly Reported from Korea

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ABSTRACT

Three freshwater ciliates, *Lembadion lucens* (Maskell, 1887) Kahl, 1931, *L. bullinum* (Müller, 1786) Perty, 1849, and *L. magnum* (Stokes, 1887) Kahl, 1931, belonging to the genus *Lembadion* Perty, 1849 are newly reported from Korea with detailed descriptions and illustrations based on live observation and protargol impregnation. *Lembadion lucens* is characterized by following characteristics: 52−91 × 33−64 μm body size *in vivo*; ovoid and slightly asymmetric body shape; 27−49 somatic kineties; and 55−80% of whole pellicle covered with meridional lines with rectangular meshes in posterior portion. *Lembadion bullinum* is distinguishable from its congeners by its body size of 110−130 × 60−73 μm *in vivo*; ovoid body shape; oral aperture occupying about four-fifths of ventral side; 48−55 somatic ciliary rows; meridional lines with rectangular meshes except anterior portion (about 16% of body) on pellicle. *Lembadion magnum* is also characterized by its body size of 70−90 × 37−50 μm *in vivo*; obliquely asymmetric anterior end of body; oral aperture occupying about more than four-fifths of ventral surface, and opened longitudinally entire ventral surface; 45−61 somatic ciliary rows; meridional lines without rectangular meshes on whole pellicle of body. The present study is the first description of the genus *Lembadion* from Korea.

Keywords: Ciliophora, description, taxonomy, *Lembadion*, morphology, Oligohymenophorea

INTRODUCTION

The family Lembadionidae Jankowski in Corliss, 1979 is a monotypic taxon including only the genus *Lembadion* Perty, 1849. This genus can be characterized by following features: small to medium sizes; ovoid cell shape; holotrichous somatic ciliation; large oral region composed of one long polykinetid, two paroral kineties, and three argentophilic line (Lynn, 2008). Above all, the large oral structure makes this genus easy to be recognized from other ciliates because of huge mouths that are found in the members of this genus (Carey, 1992). Presently, more than 20 species have been described but only five valid species are known in the genus *Lembadion*: *L. bullinum* Perty, 1849; *L. lucens* (Maskell, 1887) Kahl, 1931; *L. magnum* (Stokes, 1887) Kahl, 1931; *L. conchoides* Fauré-Fremiet, 1924; *L. gabonensis* Dragesco, 1965 (see Maskell, 1887; Kahl, 1931; Dragesco and Dragesco-Kernéis, 1986; Song and Wilbert, 1989; Guinea et al., 1990; Carey, 1992; Foissner et al., 1994; Jankowski, 2007). In this study, we report three species, *L. lucens*, *L. bullinum*, *L. magnum*, from Korea with illustrations and morphometric data based on the Korean materials.

MATERIALS AND METHODS

Materials of *Lembadion* were collected from four localities in South Korea during the periods from 30 Jun 2004 to 6 Oct 2016 (Table 1). The upper sediments of littorals in freshwater pond, reservoir, and stream valleys were sampled, and transferred to the laboratory. The transported samples were put into petri dishes and were maintained at room tempera-

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Table 1. Information of the sampling sites

Site	Locality	GPS	Sampling date	Species	Biotope
1	Jeollanam-do, Jindo-gun, Uisin-myeon, Sacheon-ri	34°28′7″N, 126°18′24″E	2 Aug 2016	*Lembadion lucens*	Freshwater (small valley)
2	Jeollanam-do, Jindo-gun, Jindo-eup, Nokjin-ri	34°33′51″N, 126°17′9″E	30 Jun 2004	*L. bullinum* *L. magnum*	Freshwater (a littoral pond)
3	Gwangju, Buk-gu, Geumgok-dong	35°09′48″N, 126°59′56″E	6 Oct 2016	*L. bullinum*	Freshwater (small valley)
4	Ulsan, Uljun-gun, Eonyang-eup, Daegok-ri	35°36′10″N, 129°11′30″E	4 Jul 2004	*L. lucens*	Freshwater (a reservoir)

ture with wheat grains as a food resource. Silver impregnations were applied to observe ciliary pattern and oral structures (Wilbert, 1975; Foissner, 1991). By observing the live specimen, cell shape, contractile vacuoles, and excretory pores were examined. The observation of live and silver impregnated specimens was conducted with a bright field and differential interference contrast microscopy (Axio Imager. A1; Carl Zeiss, Germany).

SYSTEMATIC ACCOUNTS

Phylum Ciliophora Doflein, 1901
Subphylum Intramacronucleata Lynn, 1996
Class Oligohymenophorea de Puytorac et al., 1974
Subclass Peniculia Fauré-Fremiet in Corliss, 1956
Order Peniculida Fauré-Fremiet in Corliss, 1956
Family Lembadionidae Jankowski in Corliss, 1979
Genus *Lembadion* Perty, 1849

Lembadion lucens (Maskell, 1887) Kahl, 1931 (Table 2, Figs. 1, 2)

Thurophora lucens Maskell, 1887: 16.
Lembadion lucens: Kahl, 1931: 327; Dragesco and Dragesco-Kernéis, 1986: 337; Song and Wilbert, 1989: 111; Guinea et al., 1990: 553; Foissner et al., 1994: 205.

Material examined. Korea: Jindo population: Jeollanam-do, Jindo-gun, Uisin-myeon, Sacheon-ri, 2 Aug 2016, 28 live and 36 protargol impregnated specimens; Ulsan population: Ulsan, Uljun-gun, Eonyang-eup, Daegok-ri, 4 Jul 2004, 13 live and 11 silver impregnated specimens were observed and analyzed biometrically.

Description. Body size about 65–91 × 39–64 μm (Jindo population) and 52–65 × 33–50 μm (Ulsan population) *in vivo*, on average 80 × 50 μm (Jindo population) and 60 × 45 μm (Ulsan population); length : width ratio 1.6 : 1 (Jindo population) and 1.3 : 1 (Ulsan population) *in vivo* (Table 2). Body shaped boat- or ovoid-like, inflexible, dorsoventrally flattened with concave oral area on ventral surface, convex on dorsal surface, and slightly asymmetric at anterior end (Figs. 1A, 2A, D, F).

Cytoplasm colorless with several food vacuoles (Figs. 1A, 2D, F). One spherical contractile vacuole placed dorsally in equatorial region of cell, with one long collecting canal connected to excretory pore (Figs. 1A, E, 2A, D). One excretory pore placed near proximal end of undulating membranes on ventral side (Figs. 1B, 2A). Dark greenish cortical granules globular, irregularly scattered in whole cell. One bean- or kidney-shaped macronucleus, about 24 μm *in vivo*, positioned posterior end of cell (Figs. 1A, D, 2F). One globular or ellipsoid micronucleus about 4.1 μm long *in vivo*, close to macronucleus (Figs. 1A, 2F).

Locomotion by swimming with rotation around longitudinal axis, occasionally gliding on substrate.

Oral aperture occupying almost four-fifths on ventral side, composed of long adoral membranes, undulating membranes, and argyrophilic fibrils (Figs. 1A, B, G, H, 2B, F, G). Buccal cavity surrounded by long adoral membranes on left margin, undulating membranes on right margin (Figs. 1B, 2B, G). Adoral membranes beginning at anterior end of cell, expending to posterior region of cell (Fig. 2E). Undulating membranes placed closely along right side of buccal cavity (Figs. 1B, 2B, F, G). Outer undulating or paroral membrane reaching near proximal end of adoral membranes, while inner undulating or endoral membrane not to proximal end of buccal cavity (Fig. 1D). Longitudinal argyrophilic fibril lines present between adoral membranes and undulating membranes (Figs. 1B, E, 2B).

Somatic kineties 38–49 (Jindo population) and 27–33 (Ulsan population) in number, consisted of dikinetids, occasionally, monokinetid, forming posterior sutures on ventral side (Figs. 1B, C, 2B, C, G, H). 8–12 (Jindo population) and 6–10 (Ulsan population) caudal cilia consisted of monokinetids (Figs, 1A, F, H, 2A, F, I). Pellicle rowed meridionally with rectangularly meshed parallel lines in posterior portion about 80% (Jindo population) or about 55% (Ulsan population) of cell, and these lines extended to anterior portion

Table 2. Morphometric data of Korean populations of *Lembadion* species from live and silver impregnated specimens

Characters	Species	Min	Max	Mean	SD	CV	n
Body length, *in vivo*	*L. lucens* (J)	65.4	90.5	80.3	6.16	7.7	28
	L. lucens (U)	52	65	58.5	4.6	7.9	13
	L. bullinum	110	130	120	7.2	6.0	14
	L. magnum	70	90	81	6.1	7.6	15
Body width, *in vivo*	*L. lucens* (J)	38.5	63.6	49.8	6.56	13.2	28
	L. lucens (U)	33	50	41.9	5.4	12.8	13
	L. bullinum	60	73	68.4	4.7	6.9	14
	L. magnum	37	50	45.7	4.4	9.7	15
Body length/width, *in vivo*	*L. lucens* (J)	1.3	1.9	1.6	0.16	10	28
	L. lucens (U)	1.2	1.6	1.41	0.1	10.3	13
	L. bullinum	1.6	1.8	1.76	0.06	3.32	14
	L. magnum	1.6	1.9	1.78	0.1	5.73	15
Buccal field, length	*L. lucens* (J)	55.9	75.8	68.5	4.54	6.6	36
	L. lucens (U)	40.7	51.4	46.1	4.1	7.3	13
	L. bullinum	87	99	94.1	4.6	9.2	14
	L. magnum	62.9	78.3	71.3	5.6	8.1	13
Buccal length/Body length (%)	*L. lucens* (J)	66.3	89	79.6	4.43	5.6	36
	L. lucens (U)	77.2	79.1	78.8	5.6	8.1	15
	L. bullinum	76.1	79.1	78.4	4.8	6.3	14
	L. magnum	89.8	87.2	88	6.4	7.8	15
Macronucleus, length	*L. lucens* (J)	18.2	27.6	23.8	2.89	12.1	20
	L. lucens (U)	14.5	19.8	17.3	2.5	10.7	11
	L. bullinum	32	38	35.2	3.6	9.7	11
	L. magnum	21	34	28.6	4.68	16.4	11
Micronucleus, length	*L. lucens* (J)	2.9	4.9	4.1	0.56	13.7	10
	L. lucnes (U)	2.3	3.6	3.2	1.1	13.8	11
	L. bullinum	4.1	7.9	6.4	1.3	14.4	11
	L. magnum	5	10	7.9	1.6	19.8	11
Macronucleus, number	*L. lucens* (J)	1	1	1	0	0	20
	L. lucens (U)	1	1	1	0	0	11
	L. bullinum	1	1	1	0	0	11
	L. magnum	1	1	1	0	0	11
Micronucleus, number	*L. lucens* (J)	1	1	1	0	0	10
	L. lucens (U)	1	1	1	0	0	11
	L. bullinum	1	1	1	0	0	11
	L. magnum	1	1	1	0	0	11
Somatic kineties, number	*L. lucens* (J)	38	49	42.6	2.83	6.6	35
	L. lucens (U)	27	33	29.8	2.4	7.9	11
	L. bullinum	48	55	51.6	2.4	4.6	11
	L. magnum	45	61	51.8	6.3	12.1	11

Measurement of length and width in μm.
Min, minimum; Max, maximum; Mean, arithmetic mean; SD, standard deviation; CV, coefficient of variation in %; n, number of individuals examined; J, Jindo population; U, Ulsan population.

about 20% (Jindo population) or 45% (Ulsan population) of cell without rectangular meshes (Figs. 1B, C, H, I, 2C, J).

Distribution. Austria, Cameroon, Germany, Japan, and Korea (present study).

Voucher slides: One slide including protargol-impregnated specimens is deposited in the National Institute of Biological Resources in Korea (NIBRPR0000107217), and another slide in the University of Ulsan.

Remarks. *Lembadion lucens* resembles both *L. conchoides* and *L. gabonesis* in having large oral apertures and ovoid cell shapes. However, the former can be distinguished from the other two by caudal cilia (presence vs. absence) (Carey, 1992; Foissner et al., 1994).

Lembadion lucens is similar to *L. bullinum* in terms of ovoid cell shape, the presence of caudal cilia, the pattern of line system of pellicle, and the ratio of buccal cavity. However, *L. lucens* differs from *L. bullinum* by body size (65−91 μm in *L. lucens* vs. 120−200 μm in *L. bullinm*) (Carey, 1992; Foissner et al., 1994).

Lembadion lucens also differs from *L. magnum* by cell size (65−91 μm in *L. lucens* vs. 100−200 μm in *L. magnum*), form of anterior body end (slightly asymmetric in *L. lucens*

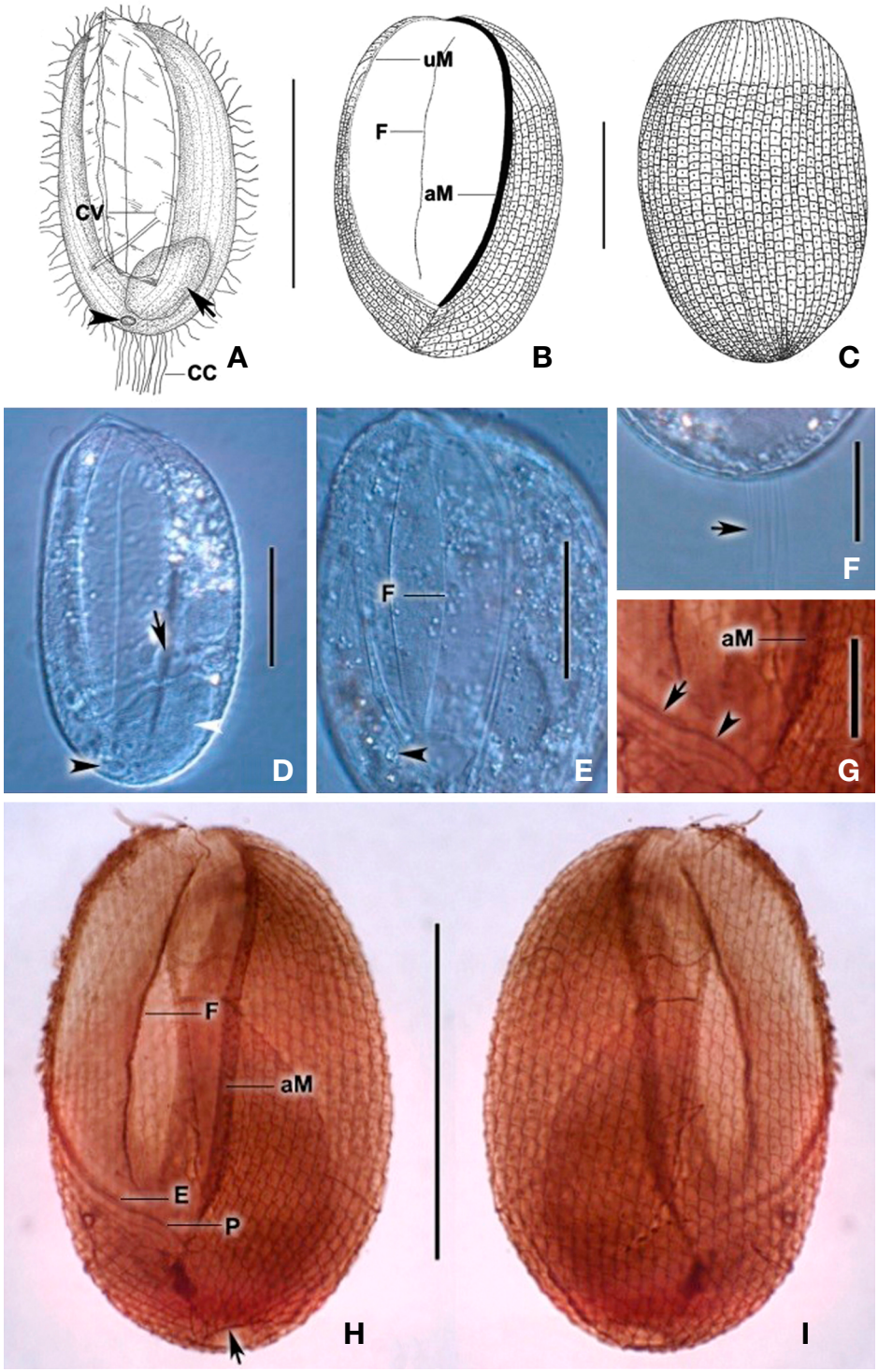

Fig. 1. Morphology of *Lembadion lucens* (Jindo population) from a live specimen (A, D–F) and after protargol impregnation (B, C, G–I). A, Ventral view of typical specimen, arrowhead points to micronucleus, and arrow indicates macronucleus; B, C, H, I, Ventral and dorsal view of protargol impregnated specimen, arrow points to caudal cilia; D, Typical view of specimen, arrowhead marks micronucleus, white arrowhead points to macronucleus, and arrow indicates contractile vacuole; E, Buccal cavity of *L. lucens*, arrowhead points to excretory pore; F, Posterior area of specimen, arrow marks caudal cilia; G, Oral region of cell, arrowhead indicates paroral membrane, and arrow points to endoral membrane; H, I, Ventral and dorsal sides of impregnated specimen, arrow points to caudal cilia. aM, adoral membranelles; CC, caudal cilia; CV, contractile vacuoles; E, endoral membrane; F, argyrophilic fibril; P, paroral membrane; uM, undulating membrane. Scale bars: A, H, I = 50 μm, B–E = 25 μm, F = 15 μm, G = 10 μm.

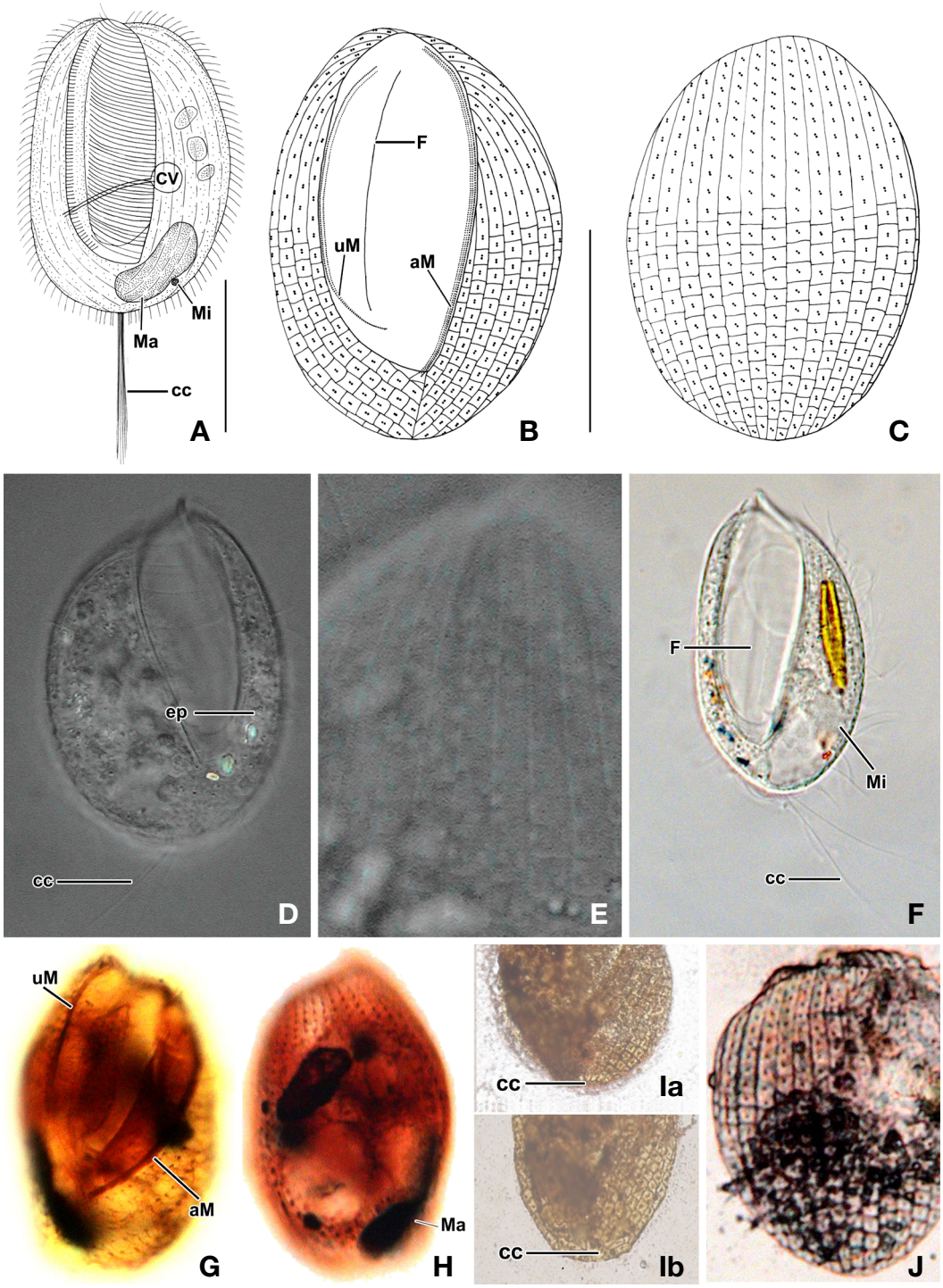

Fig. 2. Morphology of *Lembadion lucens* (Ulsan population) from a live specimen (A, D, E) and after silver impregnation (B, C, G–J). A, Typical specimen in ventral view; B, Ventral arrangement of oral apparatus and silver line system; C, Dorsal silver line system with posterior rectangular meshes in pellicle; D, Dorsal view showing excretory pore, caudal cilia, and cortical granules in cytoplasm; E, Anterior dorsal surface denoting pellicle rows without rectangular meshes; F, Typical specimen showing ventral view with fibrils in buccal cavity, micronucleus and caudal cilia; G, Ventral view showing adoral and undulating membranes impregnated with protargol; H, Dorsal somatic kineties impregnated with protargol; Ia, Ib, Arrangements of caudal cilia in short transvers lines at posterior end; J, Dorsal silver line system with posterior rectangular meshes and without rectangular meshes in anterior portion. aM, adoral membranes; cc, caudal cilia; CV, contractile vacuole; ep, excretory pore; F, argyrophilic fibrils; Ma, macronucleus; Mi, micronucleus; uM, undulating membranes. Scale bars: A–C = 30 μm.

vs. obliquely asymmetric in *L. magnum*), meridional lines on whole pellicle of body (with rectangular meshes in *L. lucens* vs. without them in *L. magnum*), and size of buccal cavity compared to body size (small in *L. lucens* vs. huge in *L. magnum*, comparatively) (Kahl, 1931; Dragesco and Dragesco-Kernéis, 1986; Foissner et al., 1994).

The Korean populations (Jindo and Ulsan) correspond well with previous populations of *L. lucens* in terms of body shape, the size of buccal cavity, the presence of the caudal cilia, the number and position of contractile vacuoles, and the system of meridional lines with rectangular meshes on the pellicle of body. However, Korean populations represent minor differences from previous populations in body length (65−91 μm in Jindo and 52−65 μm in Ulsan populations vs. 50−70 μm in previous populations) and the number of the somatic kineties (27−33 in Ulsan and 38−49 in Jindo populations vs. 25−35 in previous populations) (Kahl 1931; Dragesco and Dragesco-Kernéis, 1986; Song and Wilbert, 1989; Guinea et al., 1990; Foissner et al., 1994). When considering the high coefficient of variation (CV) in these characters, these differences can be a result of variations of populations which depend on the microhabitats differences in localities. In addition, the giant form was reported by unknown gaint inducing factor in the closest relative (*Lembadion bullinum*) of this species (Kuhlmann, 1993). Therefore it is not easy to determine the exact status of these populations and more detailed studies are required to confirm the exact status of these populations.

***Lembadion bullinum* (Müller, 1786) Perty, 1849**
(Table 2, Fig. 3)

Bursaria bullina Müller, 1786: 116.
Lembadion bullinum: Perty, 1849: 171; Kahl, 1931: 327; Dragesco, 1970: 60; Carey, 1992: 132; Foissner et al., 1994: 212.

Material examined. Korea: Jeollanam-do, Jindo-gun, Jindo-eup, Nokjin-ri, 30 Jun 2004, 14 live and 11 silver impregnated specimens were observed respectively and analyzed biometrically.

Description. Body size about 110−130 × 60−73 μm *in vivo*; length about 1.8 times of width (Table 2). Body shape more or less ovoid, inflexible, ventral surface flat to slightly concave, dorsal surface convex and rough, slightly asymmetric at anterior end (Fig. 3A, F, G).

Cytoplasm colorless with several food vacuoles (Fig. 3D, G). One spherical contractile vacuole placed dorsally in subequatorial region of cell, with one long collecting canal connected to excretory pore (Fig. 3A, F, G). One excretory pore placed near proximal end of undulating membranes on ventral side (Fig. 3G, J). Cortical granules difficult to find in whole cell. One bean- or kidney-shaped macronucleus, about 40 μm *in vivo*, positioned posterior end of cell (Fig. 3A, G, I). One globular or ellipsoid micronucleus about 4 μm long *in vivo*, close to macronucleus (Fig. 3A, F).

Locomotion by swimming with rotation around longitudinal axis, occasionally gliding on substrate.

Oral aperture occupying almost four-fifths on ventral side, composed of long adoral membranes, undulating membranes, and argyrophilic fibrils (Fig. 3A, B, D, G, J). Buccal cavity surrounded by long adoral membranes on left margin, undulating membranes on right margin (Fig. 3B, G, H, I, J). Adoral membranes beginning at anterior end of cell, expending to posterior region of cell (Fig. 3B, G, H, I). Undulating membranes placed closely along right side of buccal cavity (Fig. 3B, I, J). Outer undulating or paroral membrane reaching near proximal end of adoral membranes, while inner undulating or endoral membrane not to proximal end of buccal cavity (Fig. 3B, J). Longitudinal argyrophilic fibril lines present between adoral membranes and undulating membranes (Fig. 3B, I).

Somatic kineties 48−55 in number, consisted of dikinetids, occasionally, monokinetid, forming posterior sutures on ventral side (Fig. 3B, D, J). 10−16 caudal cilia in two short transverse lines consisted of monokinetids (Fig. 3B, F, K). Pellicle rowed meridionally with rectangularly meshed parallel lines in posterior portion about 84% of cell, and these lines extended to anterior portion about 16 % of cell without rectangular meshes (Fig. 3B, C, J, K).

Distribution. Austria, Cameroon, England, Germany, Japan, United States, and Korea (present study).

Voucher slides: One slide including protargol-impregnated specimens is deposited in the University of Ulsan, and another slide in the National Institute of Biological Resources in Korea (NIBRPR0000107218), respectively.

Remarks. *Lembadion bullinum* differs from *L. gabonensis* and *L. conchoides* because the former has caudal cilia, while the other two have not them (Carey, 1992; Foissner et al., 1994).

Lembadion bullinum resembles *L. lucens* in terms of body shape and the system of meridional lines with rectangular meshes. However, the former is different from the latter by body size in length (120−200 μm vs. 50−70 μm) and the number of somatic kineties (50−70 vs. 25−35) (Foissner et al., 1994).

Lembadion bullinum is similar to *L. magnum* in terms of body size, the location of the contractile vacuole and nucleus, and the number of the somatic kineties. However, the former differs from the latter by the system of meridional lines with rectangular meshes in pellicle (with rectangular meshes vs. without them) (Kahl, 1931; Dragesco and Dragesco-Kernéis, 1986; Foissner et al., 1994).

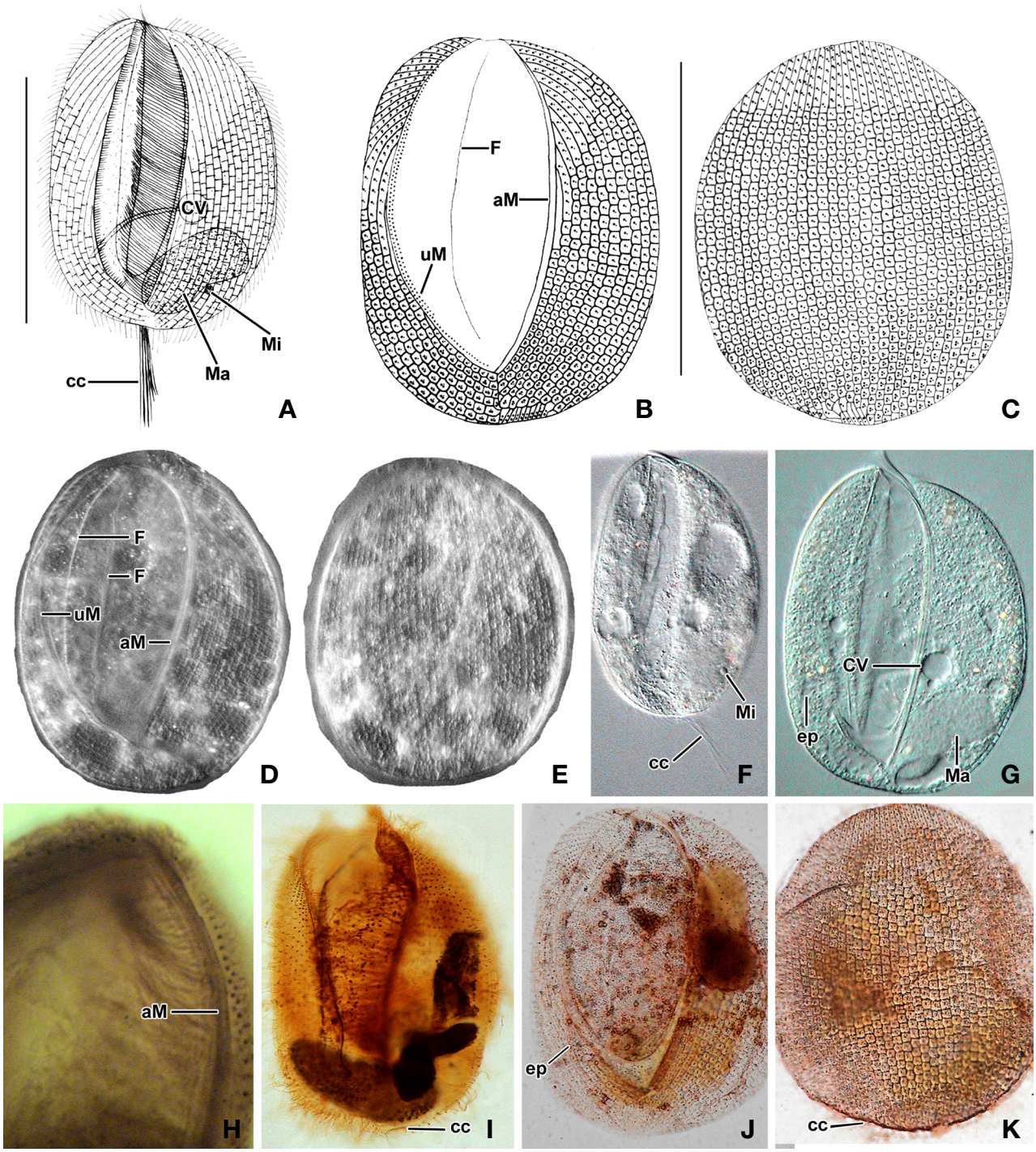

Fig. 3. Morphology of *Lembadion bullinum* from a live specimen (A, D–G) and after silver impregnation (B, C, H–K). A, Typical specimen in ventral view; B, Ventral arrangement of oral apparatus and silver line system; C, Dorsal silver line system with posterior rectangular meshes in pellicle; D, Ventral view showing oral apparatus, pellicle lines, caudal cilia, and cortical granules in cytoplasm; E, Dorsal surface denoting pellicle rows with rectangular meshes; F, Typical specimen shows ventral view with fibrils in buccal cavity, micronucleus and caudal cilia; G, Ventral view showing contractile vacuole and excretory pore; H, Ventral view showing adoral membranes impregnated with protargol; I, Ventral view showing oral apparatus and caudal cilia in short transvers lines at posterior end; J, Ventral arrangement of oral apparatus and silver line; K, Dorsal silver line system with posterior rectangular meshes and without rectangular meshes in anterior portion. aM, adoral membranes; cc, caudal cilia; CV, contractile vacuole; ep, excretory pore; F, argyrophilic fibrils; Ma, macronucleus; Mi, micronucleus; uM, undulating membranes. Scale bars: A–C = 100 μm.

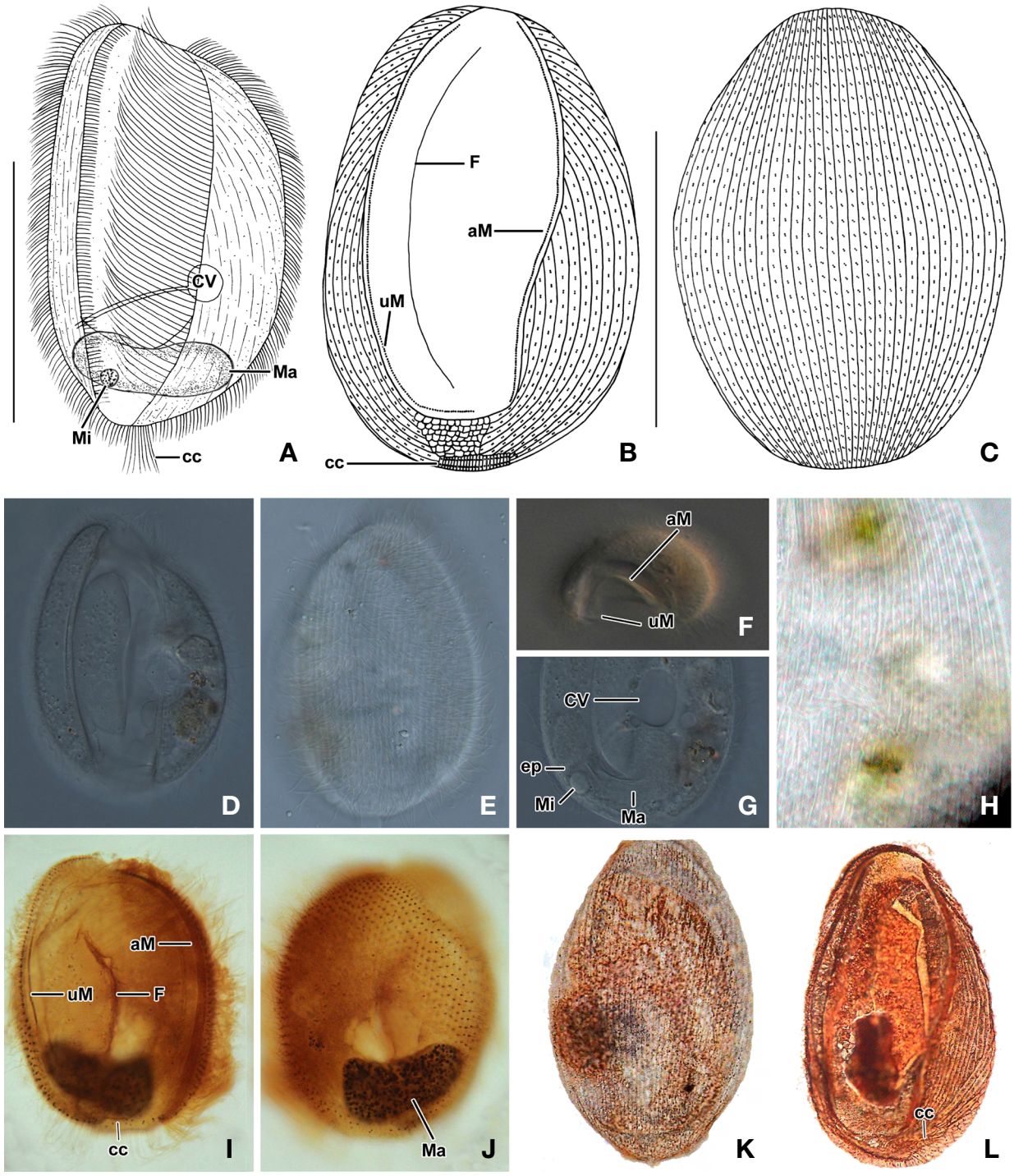

Fig. 4. Morphology of *Lembadion magnum* from a live specimen (A, D, E) and after silver impregnation (B, C, G–J). A, Typical specimen in ventral view; B, Ventral arrangement of oral apparatus and silver line system; C, Dorsal silver line system without rectangular meshes in pellicle; D, Ventral view showing huge oral area; E, Dorsal surface denoting pellicle rows without rectangular meshes; F, Cross-sectional view showing adoral membranes and undulating membranes; G, Ventral view showing contractile vacuole and cortical granules in cytoplasm; H, Dorsal somatic kineties in pellicle; I, Ventral view showing oral apparatus and caudal cilia in short transvers lines at posterior end; J, Dorsal view showing somatic kineties and macronucleus; K, Dorsal view shoing silver line system without rectangular meshes; L, Ventral view showing oral apparatus and caudal cilia. aM, adoral membranes; cc, caudal cilia; CV, contractile vacuole; ep, excretory pore; F, argyrophilic fibrils; Ma, macronucleus; Mi, micronucleus; uM, undulating membranes. Scale bars: A–C = 50 μm.

Although the Korean populations of *L. bullinum* have a little smaller body size than the European populations (110−130 μm long in Korean vs. 120−200 μm long in previous populations), they correspond well with the previous populations in terms of system of meridional lines with rectangular meshes in pellicle, and the numbers of somatic kineties, contractile vacuole and nuclei (Kahl 1931; Dragesco and Dragesco-Kernéis, 1986; Song and Wilbert, 1989; Guinea et al., 1990; Foissner et al., 1994). When considering the morphometric data of body size has high CV, it is supposed that this difference of body size is the variation of populations caused by different microhabitats in regions.

***Lembadion magnum* (Stokes, 1887) Kahl, 1931 (Table 2, Fig. 4)**

Hymenostoma magna Stokes, 1887: 248.

Lembadion magnum: Kahl, 1931: 327; Dragesco and Dragesco-Kernéis, 1986: 336; Foissner et al., 1994: 219.

Material examined. Korea: Jeollanam-do, Jindo-gun, Jindo-eup, Nokjin-ri, 30 Jun 2004, 15 live and 11 silver impregnated specimens were observed, respectively, and analyzed biometrically.

Description. Body size about 70−90 × 37−50 μm *in vivo*; length of cells about 1.8 times of width (Table 2). Body shaped boat- or ovoid-like, inflexible, dorsoventrally flattened with concave oral area on ventral surface, convex on dorsal surface, and slightly asymmetric at anterior end (Fig. 4A, D, F).

Cytoplasm colorless with several food vacuoles (Fig. 4E, G, H). One spherical contractile vacuole placed dorsally in subequatorial region of body, with one long collecting canal connected to excretory pore (Fig. 4A, G). One excretory pore placed near proximal end of undulating membranes on ventral side (Fig. 4A, G). Dark greenish cortical granules globular, irregularly scattered in whole cell (Fig. 4G). One bean- or kidney-shaped macronucleus, about 28 μm *in vivo*, positioned posterior end of cell (Fig. 4A, G). One globular or ellipsoid micronucleus about 8 μm long *in vivo*, close to macronucleus (Fig. 4A).

Locomotion by swimming with rotation around longitudinal axis, occasionally gliding on substrate.

Huge oral aperture occupying more than four-fifths of body length on ventral side, composed of long adoral membranes, undulating membranes, and argyrophilic fibrils (Fig. 4A, B, I, L). Buccal cavity surrounded by long adoral membranes on left margin, undulating membranes on right margin (Fig. 4B, D, I, L). Adoral membranes beginning at anterior end of cell, expending to posterior region of cell (Fig. 4B, D, I, L). Undulating membranes placed closely along right side of buccal cavity (Fig. 4B, D, I, L). Outer undulating or paroral membrane reaching near proximal end of adoral membranes, while inner undulating or endoral membrane not to proximal end of buccal cavity (Fig. 4B, I, L). Longitudinal argyrophilic fibril lines present between adoral membranes and undulating membranes (Fig. 4B, I).

Somatic kineties 45−61 in number, consisted of dikinetids, occasionally, monokinetid, forming posterior sutures on ventral side (Fig. 4B, L). About 22 caudal cilia in two short transverse lines consisted of monokinetids (Fig. 4B, I, L). Pellicle rowed meridionally without rectangularly meshed parallel lines (Fig. 4B, C, E, K).

Distribution. Africa, Austria, England, and Korea (present study).

Voucher slides: One slide including protargol-impregnated specimens is deposited in the University of Ulsan and another slide in slide in the National Institute of Biological Resources in Korea (NIBRPR0000107956), respectively.

Remarks. *Lembadion magnum* is similar to *L. bullinum* in terms of body size, the location of the contractile vacuole and nuclei, and the body shape. However, the former can be distinguished from the latter by the meridional lines on whole pellicle of body (with rectangular meshes in *L. bullinum* vs. without them in *L. magnum*) (Carey, 1992; Foissner et al., 1994).

Lembadion magnum is different from *L. lucens* by having obliquely asymmetric anterior end (vs. slightly asymmetric anterior end in *L. lucens*), longitudinally striated silver-line pattern on whole pellicle (vs. rectangular shaped pellicle on posterior region in *L. lucens*), bigger buccal cavity (Kahl, 1931; Dragesco and Dragesco-Kernéis, 1986; Foissner et al., 1994).

Lembadion magnum also differs from *L. gabonensis* and *L. conchoides* in that the former has caudal cilia while the other two have no caudal cilia (Carey, 1992; Foissner et al., 1994).

The Korean population of *L. magnum* corresponds well with the previous populations of it in most features, except for body size in length (70−90 μm in Korean vs. 100−200 μm in previous populations) (Kahl, 1931; Dragesco and Dragesco-Kernéis, 1986; Foissner et al., 1994).

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